
Caobangia, a New Genus and Species of Polypodiaceae from Vietnam

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ABSTRACT. We describe and illustrate the monotypic new genus and species *Caobangia squamata* (Polypodiaceae), endemic to limestone ridges in northern Vietnam. *Caobangia* is superficially similar to the predominantly Neotropical genera *Microgramma* and *Pleopeltis*, but its affinities appear to be with *Lepidogrammitis*, comprising about eight species in China and southeastern Asia. *Caobangia* is characterized by long-creeping filiform rhizomes, clathrate rhizome scales, simple, monomorphic to subdimorphic, densely acicular-scaly blades, and a single row of sori on each side of the midrib.

Key words: *Caobangia*, Polypodiaceae, Vietnam.

Discovery of a new genus of ferns, based solely on previously undescribed species of an avowedly non-hybrid nature, is an uncommon event. Quite recently, a new genus and species (*Mankyua chejuense* B.-Y. Sun et al.) of the eusporangiate fern family Ophioglossaceae was described from Cheju Island, Korea (Sun et al., 2001), but previous to that, the last such new genera of which we are aware were the description of *Podosorus angustatus* Holttum (1966), Polypodiaceae, from the Philippines, *Cystoathyrium chinense* Ching (1966), Athyriaceae, from China, and *Nephtopteris maxonii* Lellinger (1966), Pteridaceae, from Colombia.

Recent pteridophyte floras of areas within eastern Asia fail to provide clues as to the identity of our species, and one quickly comes to "blind alleys" in available keys. In the recent *Flora Malesiana* treatment for Polypodiaceae (Hovenkamp et al., 1998), our undescribed taxon will key to *Lemmaphyllum* s.l. (including *Lepidogrammitis*), in the sense that name is applied by Hovenkamp, but his description of *Lemmaphyllum* is at variance with *Caobangia* in several important respects (see discussion under the new genus below). In an effort to identify the plant we describe herein, we have

consulted, without success, keys to genera and species from the following areas: Vietnam (Tardieu-Blot & Christensen, 1941; Pham-Hoàng, 1991, 1999); Thailand (Smitinand & Larsen, 1989); China (Lin, 2000); Malaysia (Holttum, 1954); Malesia (Hovenkamp et al., 1998); and Taiwan (Huang, 1994). We have also shown a specimen of the plant in question to knowledgeable colleagues in Asia (especially China and Japan), Europe, and North America, and no one has seen anything remotely resembling the plant described below. Without hesitation, therefore, we name this taxon as a new genus and species.

Caobangia A. R. Smith & X. C. Zhang, gen. nov.

TYPE: *Caobangia squamata* A. R. Smith & X. C. Zhang, Figure 1.

A *Lepisoro* et *Lepidogrammitide* laminis dense squamatis, squamis fere laminis occultantibus, rubro-brunneis, plerumque 5–6 mm longis, base peltatis clathratis marginibus dentatis, apice acicularibus non-clathratis dentatis differt; a *Lemmaphyllo* s. str. sori rotundatis discretis ca. 2 mm diametro, laminis monomorphis vel subdimorphis squamis numerosis acicularibus differt.

Rhizomes long-creeping, filiform, sparingly branched, approximately terete, dorsiventral with two rows of dorsal fronds, rather sparsely set with roots, not ant-inhabited, densely scaly; scales lacking hairs at the bases (non-comose), acicular and nearly entire from peltately attached, clathrate, strongly and irregularly toothed bases. Fronds short-stipitate to nearly sessile; stipes scaly, lacking obvious articulation lines or swellings at bases; blades herbaceous to chartaceous, entire, elliptic to ovate, monomorphic to subdimorphic in size and shape, dark green-brown when dried, stellate hairs lacking, densely scaly on both sides with persistent red-brown, hairlike scales; blade scales with peltate, clathrate, laciniate-margined bases and very long, acicular, uniformly red-brown, non-clathrate,

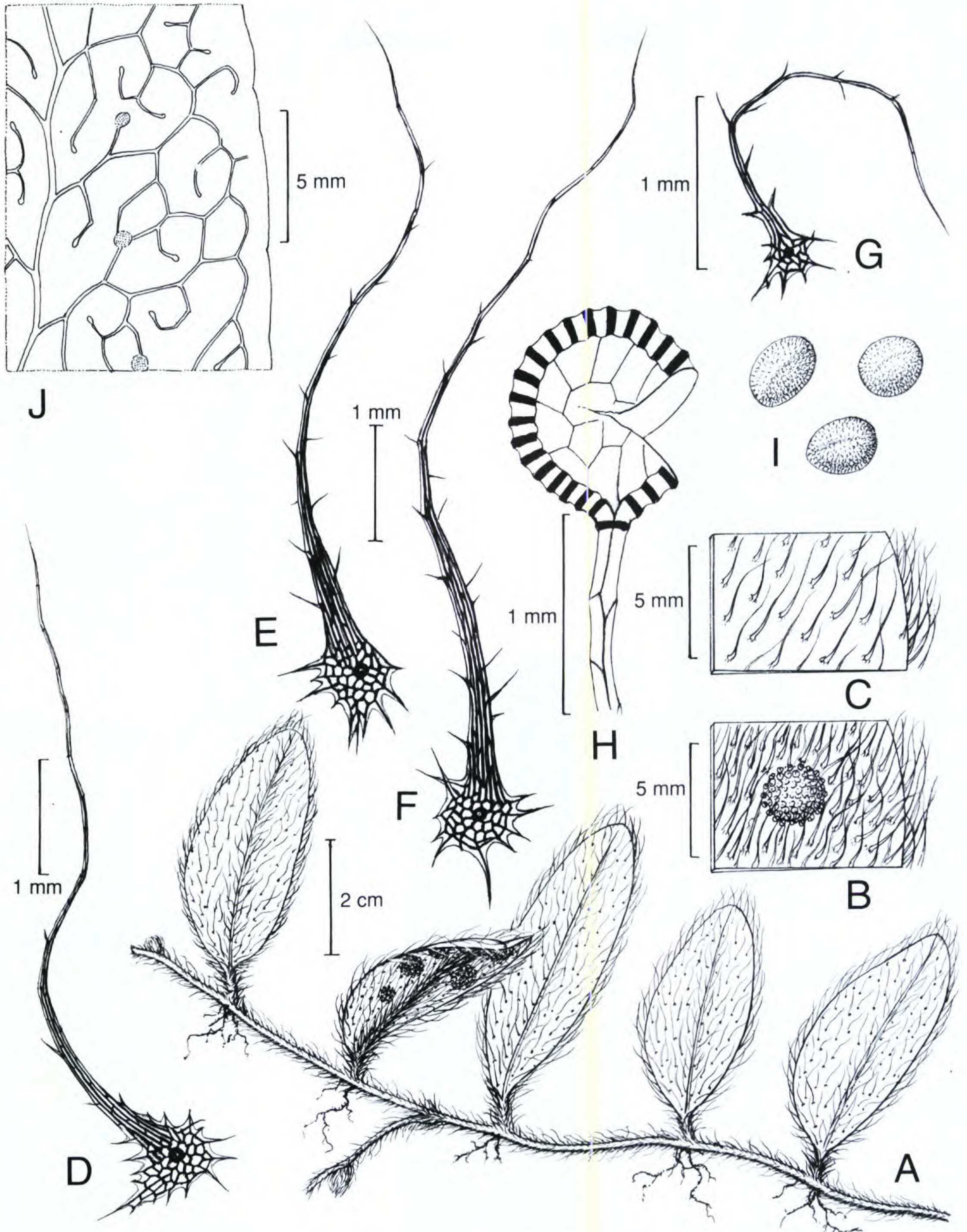


Figure 1. *Caobangia squamata* A. R. Smith & X. C. Zhang, based on *Loc et al. CBL 1698* (PE, UC). —A. Plant habit. —B. Abaxial blade surface, with sorus. —C. Adaxial blade surface. —D. Rhizome scale. —E. Scale from abaxial surface of blade. —F. Scale from adaxial surface of blade. —G. Scale near sorus. —H. Sporangium. —I. Spores. —J. Venation in a portion of fertile leaf, with scales removed; stippled areas indicate soral receptacles, with sporangia removed.

dentate to lacinate tips. Venation: midribs distinct, sclerenchymatous (darkened, but hidden by red-brown scales), main lateral veins indistinct or distinct only in the basal 1/5 or less in cleared fronds, 10–13 per side, anastomosing and forming irregular areoles (1 row of large areoles adjacent to midrib, 0–2 additional rows of smaller areoles toward margins), areoles with occasional free veinlets, these simple (unforked), almost always recurrent, immersed, not or only faintly visible adaxially, veins toward blade margins often ending freely, hydathodes lacking. Sori in single rows within the larger areoles, midway between midrib and each margin, round, not confluent, \pm obscured by acicular scales. Sporangia stalked, lacking paraphyses, with 16 to 19 indurated annulus cells, mixed with acicular scales; spores monolet, whitish, papillate to rugose, fully mature spores not seen.

The name *Caobangia* is chosen to acknowledge the area where this most distinctive fern grows. It is the name of the province, as well as the name of the capital city of the province. “Cao,” in Vietnamese, means high; “Bang” refers to a locality with more or less flat terrain. The province of Cao Bang is in a limestone area, carved with many often narrow valleys. The city of Cao Bang lies in the largest valley of this province, surrounded by high mountains. The Cao Bang limestone area is one of the richest areas for plant diversity in Vietnam, and many endemic or relatively restricted plants are known from the region (Averyanov, 1998; Loc et al., 1999a, 1999b; Hiep et al., 2000). Recent collections from this area from diverse families of ferns and seed plants have proven to be first records of species from Vietnam, e.g., *Cyrtomium hemionitis* H. Christ (Dryopteridaceae) (see <http://mobot.mobot.org/W3T/Search/vast.html>), *Loxogramme grammitoides* (Baker) C. Christensen (Polypodiaceae), *Pteris actiniopteroides* C. Christensen (Pteridaceae), *Pseudotsuga brevifolia* W. C. Cheng & L. K. Fu (Pinaceae), *Campylotropis henryi* (Schindler) Schindler (Leguminosae), *Luculia yunnanensis* S. Y. Hu (Rubiaceae), *Myrsine kwangsiensis* (E. H. Walker) Pipoly & C. Chen (Myrsinaceae), *Paphiopedilum dianthum* T. Tang & F. T. Wang and *Paphiopedilum micranthum* T. Tang & F. T. Wang (Orchidaceae), and *Swertia nervosa* (Wallich ex G. Don) C. B. Clarke (Gentianaceae) (see Loc et al., 1999b, for more examples).

The habitat of *Caobangia* is on limestone ridges in closed tropical seasonal submontane conifer forest dominated by *Pseudotsuga brevifolia* W. C. Cheng & L. K. Fu mixed with *Pinus kwangtungensis* Chun ex Tsiang, sometimes with *Calocedrus ma-*

crolepis Kurz and *Amentotaxus argotaenia* (Hance) Pilger. The common angiosperm found in the overstory is *Quercus*. In the understory (7–15 m tall) are the conifers *Nageia fleuryi* (Hickel) de Laubenfels, and *Podocarpus brevifolius* (Stapf) Foxworthy, and angiosperms *Platycarya strobilacea* Siebold & Zuccarini, *Pistacea weinmannifolia* J. Poisson ex Franchet, and species of *Acer*, *Carpinus*, *Elaeocarpus*, *Eriobotrya*, *Sorbus*, *Schefflera*, and *Ulmus*. Shrubs and herbs abound; among the latter are numerous species of Orchidaceae, terrestrial as well as epiphytic. Ferns and bryophytes are similarly abundant, both as lithophytes and epiphytes. The limestone ridges on which this forest community occurs are extremely eroded, composed of resistant, marble-like rock outcrops interspersed with thin soil pockets. The climate is tropical, with cool winters (5 months, from November to March, with mean monthly temperature below 17° Celsius) and summer rains. There is no dry period: all months have rainfall over 25 mm (see Van et al., 2000).

Affinities of this distinctive new genus are obscure, on initial inspection, other than being an undoubted member of the Polypodiaceae. Characteristics placing it firmly in Polypodiaceae include the long-creeping, sparingly branched, clathrate-scaly rhizomes; articulate fronds; simple blades; areolate venation with included recurrent veinlets; lack of hairs on the blades; round, dorsal, exindusiate sori; and monolet, bilateral whitish spores. Moreover, it grows on rocks, a habitat favored by many members of this family. Within Polypodiaceae, only *Platycterium* and *Pyrrosia* in the Paleotropics and subtropics bear such dense scales on the blade, and the scale type found in *Caobangia* (peltate-acicular and clathrate at the base) is strongly at variance with the stellate scales found in platycteriid genera. We suggest that *Caobangia* is probably a member of the lepisoroid clade, comprising the genera *Drymotaenium*, *Lepisorus*, *Lepidogrammitis*, *Lemmaphyllum*, and, more remotely, *Belvisia* (tribe Lepisoreae of Henningman et al., 1990). From all of these, *Caobangia* differs in the densely scaly blades. Additionally, from *Lepisorus* it differs in lacking peltate scales from the receptacle. *Caobangia* is more distantly related to the microsoroid genera, which include *Microsorium*, *Leptochilus*, *Neocheiropteris*, *Colysis*, and *Phymatosorus* (Nooteboom, 1997, 1999), and it differs from these by the single regular row of sori between midrib and blade margin and the abundant peltate-acicular scales on the blades.

The closest living relative of *Caobangia* may be the genus *Lepidogrammitis* Ching, sometimes treated as a synonym of *Lemmaphyllum* (e.g., by Henningman et al., 1990). *Lepidogrammitis* (Ching,

1940), which we prefer to recognize at generic rank, comprises perhaps eight species in China and southeastern Asia (Lin, 2000). It is characterized by long-creeping, filiform rhizomes, clathrate rhizome scales, fronds with simple, monomorphic to subdimorphic or dimorphic blades, and, on each fertile blade, a single row of sori on each side of the midrib. Most of the species are restricted to China. *Lepidogrammitis* differs from *Caobangia* in having the rhizome scales decidedly clathrate throughout their entire length (including tips), glabrous or nearly glabrous, subcoriaceous or fleshy blades, strongly articulate stipe bases, and presence of stalked peltate scales within the sori. The venation in at least some species of *Lepidogrammitis* (see, e.g., Lin, 2000, fig. 19.8, *Lepidogrammitis drymoglossoides* (Baker) Ching) is similar to that of *Caobangia* (Fig. 1J) except that in *Caobangia* there is a less continuous intramarginal union of the vein tips around the periphery of the blade, and veins of *Caobangia* often end freely near the margin.

If one compares *Lemmaphyllum* sensu Hovenkamp (in Hovenkamp et al., 1998) with *Caobangia*, one notes the following differences: rhizome scales peltately attached at the base (never basifixed, as described for some *Lemmaphyllum*), scales also acicular and essentially entire beyond the base (vs. dentate to lacerate in *Lemmaphyllum*); blades herbaceous to chartaceous, densely scaly on both surfaces (vs. more or less succulent and glabrous or essentially so in *Lemmaphyllum*); veins forming one large and an incomplete smaller second row of areoles between midrib and margin (vs. 2 or 3 rows of areoles in *Lemmaphyllum*; see, e.g., fig. 19.2 in Lin, 2000); and sori round (vs. round to elliptic to longitudinally coenosoriolate in *Lemmaphyllum*), sori lacking round-peltate paraphyses (vs. paraphyses round-peltate in *Lemmaphyllum*). Fronds of *Lemmaphyllum* s. str. (2 or 3 species) are often strongly dimorphic, and the sori appear linear and subacrostichoid (confluent) at maturity. *Lemmaphyllum carnosum* (Hooker) C. Presl bears a few scattered scales on the lamina abaxially (e.g., *van der Werff et al.* 14216, UC, from Vietnam), but these are round-peltate to ovate, much less strikingly acicular than those in *Caobangia*, only about 1 mm long, and strongly clathrate throughout. *Lemmaphyllum accedens* (Blume) Donk, sometimes placed in the segregate genus *Weatherbya*, is widespread in Malesia to Polynesia and is yet more distantly related. Both *Lemmaphyllum* s. str. and *Lepidogrammitis* are relatively common epiphytes in low-elevation forests in southern China and southeast Asia.

There is no close relationship that we see to any

known genus of New World Polypodiaceae. From *Pleopeltis*, perhaps the most superficially similar genus, *Caobangia* differs in having acicular scales from a peltate base on all parts of the blades (instead of round-peltate scales). The rhizome scales of *Caobangia* are non-comose and uniformly colored, contrasting with the comose, bicolored scales found in many species of *Pleopeltis*. *Microgramma*, also with simple blades, has non-clathrate rhizome scales lacking acicular tips; it is more remotely related, although still somewhat superficially similar. Unpublished molecular work by Haufler et al. place *Pleopeltis* and *Microgramma* solidly within a large clade of Neotropical Polypodiaceae, and separate from nearly all Old World genera of Polypodiaceae, which form their own large clade (Schneider et al., ms. in prep.).

Caobangia squamata A. R. Smith & X. C. Zhang, sp. nov. TYPE: Vietnam. Cao Bang: Ha Lang, Thang Loi, vicinity of Lung Sam village, 22°45'N, 106°42'E, 550–600 m, 24 Apr. 1999, P. K. Loc, P. H. Hoang & L. Averyanov CBL 1698 (holotype, HN not seen; isotypes, LE not seen, KUN not seen, MO 5291090 not seen, PE, UC). Figure 1.

A *Lepidogrammitide rostrata* (Beddome) Ching laminis dense squamatis, squamis fere laminis occultantibus, rubro-brunneis, plerumque 5–6 mm longis, base peltatis clathratis, marginibus dentatis vel laciniatis, apice acicularibus dentatis non-clathratis differt.

Rhizomes ca. 1 mm diam., 2–4 cm between stipe bases, densely covered with numerous ascending and outwardly curved, overlapping scales; scales dark red-brown, ca. 5 mm long, peltate bases ca. 0.4–1.2 mm wide (including teeth), also with a few short teeth to 0.2 mm long in proximal third of the long acicular scale tips, distal portion of scales uniseriate for 1–2 mm. Fronds to 7.5 × 1.8 cm; stipes mostly 1–10 mm long, with scales similar to those of blades; sterile blades ovate to broadly elliptic or short-oblong, often shorter and more rounded than the fertile at their bases but equaling the fertile in width (transitional shapes appear to occur), mostly ca. half the length of the fertile fronds or less, rounded at tips, densely covered (but some laminar tissue visible between overlapping scales) on both sides with persistent scales mostly 5–6 mm long, scales acicular from peltate, clathrate, dentate-margined or laciniate bases, the acicular tips uniformly red-brown and non-clathrate, bearing up to ca. 10 teeth per side, teeth up to 0.3 mm long, scales curved and ascending or spreading, extending up to 5 mm beyond blade margins. Sori up to ca. 9 on

each side of midrib, up to 2 mm diam., difficult to see because of the dense overlayer of scales.

Plants rare, epipetric on vertical shaded limestone cliffs of northern exposure, in secondary wet evergreen broadleaved forest with remnants of primary elements on steep slopes and bluffs of karst remnant limestone ridge. The type was distributed under the name *Lepisorus*, and is the only known collection.

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